Reasonable Potential Determination

Introduction

To determine if a water quality-based effluent limitation is required, the receiving water concentration of pollutants is determined downstream of where the effluent enters the receiving water. If the projected receiving water concentration is greater than the applicable numeric criterion for a specific pollutant, there is reasonable potential that the discharge may cause or contribute to an excursion above the applicable water quality standard and an effluent limit must be incorporated into the NPDES permit. The reasonable potential determination was performed for copper and lead since water effect ratios (which create a site-specific adjustment of the water quality criteria, WERs) and new effluent and receiving water data are now available for these parameters. EPA followed guidance in the *Technical Support Document for Water Quality-based Toxics Control* [1](TSD) in making the reasonable potential determination.

Water Effect Ratios (WERs) and Water Quality Criteria

In the reasonable potential determination, the receiving water concentration is compared to the applicable water quality criteria. The water effect ratio (WER) is an adjustment to the water quality criteria to make up for the difference between site water and laboratory water that was used to develop the water quality criteria.

The toxicity of a metal to aquatic organisms can be influenced by various physical and chemical characteristics of the receiving water and the metal. Metals criteria developed nationally and statewide for freshwater organisms using toxicity bioassay tests in laboratory water may not always be appropriate for a site specific receiving water. Based on the particular characteristics of a receiving water, it may be appropriate to develop site-specific criteria. One of the acceptable methods of doing this is to use an adjustment procedure based on the toxicological determination of a WER that accounts for the difference between the toxicity of the metal in laboratory dilution water and its toxicity in the receiving water at the site. After a WER is determined for a site, a site-specific aquatic life criterion can be calculated by multiplying the appropriate national, state, or recalculated criterion by the WER.[2]

In order to determine a WER, side-by-side toxicity tests are performed to measure the toxicity of the metal in two dilution waters (site water and laboratory water). The WER is calculated by dividing the endpoint obtained in the site water by the endpoint obtained in the

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[1] *Technical Support Document for Water Quality-based Toxics Control*, **EPA/505/2-90-001, March 1991.**

[2] *EPA Interim Guidance on Determination and Use of Water-Effect Ratios for Metals*, **EPA-823-B-94-001, February 1994.**

laboratory dilution water. A WER should be determined using a toxicity test whose endpoint is close to, but not lower than, the criterion maximum concentration, CMC, (i.e., acute criterion) and/or the criterion continuous concentration, CCC (i.e., the chronic criterion) that is to be adjusted.

The City conducted a study to determine WERs for copper and lead. The City followed EPA guidance in developing the WERs. In a letter dated July 24, 2002, IDEQ transmitted its approval of the WERs developed by the City of Boise.[3] The WERs have been incorporated into this permit modification and will go through the public notice and comment of the draft permit. At the same time, though, IDEQ has published the WERs and is taking public comment on them. EPA and IDEQ worked together in reviewing the WER study submitted by the City. Based on the results of the WER study by the City, the following WERs were developed and apply to both the Lander Street and West Boise Wastewater Treatment Facilities.

TABLE 1		WERs and Adjusted Aquatic Life Criteria for Boise River at Lander Street WWTF[4]					
Metal	WER	Season	Criteria w/o WER		Adjusted	
			Acute Criterion	Chronic Criterion	Acute Criterion	Chronic Criterion
Copper	2.578	Apr - Sept	8.02	5.08	20.67 ug/L	13.09 ug/L
		Oct - March	8.86	6.17	22.83 ug/L	15.91 ug/L
Lead	2.049	Apr - Sept	26.81	0.891	54.93 ug/L	1.82 ug/L
		Oct - March	30.14	1.15	61.75 ug/L	2.35 ug/L

The criteria used for this draft permit modification have changed slightly from the criteria used in developing the current permit limits scheduled to go into effect in 2003 and 2004. One of the reasons for the change is that the data collected over the past two years indicate that the background no longer exceeds criteria for lead. As a result, lead criteria have been recalculated using a mixed hardness, rather than effluent hardness.

Reasonable Potential Equation

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[3]   **David Mabe, State Water Quality Programs Administrator, IDEQ, to Randall F. Smith, Director, Office of Water, EPA Region 10, "Re: Copper and Lead Criteria for the City of Boise Discharge," dated July 24, 2002.**

[4]   **IDAPA 58.01.02.210.02.d.**

EPA uses the following steps in analyzing effluent discharges for reasonable potential. These steps include: reviewing available data, using that data to identify maximum effluent concentration, using that maximum concentration to calculate a projected receiving water concentration (RWC), comparing the RWC to the numeric objective/criterion, and developing permit limits where the projected RWC is greater than the numeric objective/criterion.

The receiving water concentration is determined using the following mass balance equation.

$Q_d C_d = Q_e C_e + Q_u C_u$	
where,	
$Q_d =$	**downstream flow = $Q_u + Q_e$**
$C_d =$	**aquatic life criteria that cannot be exceeded downstream (expressed as dissolved)**
$Q_e =$	**effluent flow**
$C_e =$	**concentration of pollutant in effluent = WLA_{acute} or $WLA_{chronic}$ (expressed as dissolved)**
$Q_u =$	**upstream flow**
$C_u =$	**upstream background concentration of pollutant (expressed as dissolved)**

If a mixing fraction (MF) is allowed, the mass balance equation becomes

$$C_d = \frac{(C_e \times Q_e) + (C_u \times (Q_u \times MF))}{Q_e + (Q_u \times MF)}$$

The following sections discuss the factors in the mass balance equation. Some of the factors (i.e., MF and critical flows) are the same as those used in the current permit. The Response to Comments document[5], Appendix B, provides details of all the factors used for the current permit.

Mixing Zone/MF

The Idaho water quality standards at IDAPA 58.01.02060 recommends that no more than twenty-five percent (25%) of the receiving water be used for dilution for aquatic life criteria. The reasonable potential calculations are based on a mixing fraction of 0.50 for aquatic life for copper and lead. In accordance with Idaho state water quality standards, only the Idaho Department of Environmental Quality (IDEQ) may authorize mixing zones and associated mixing fractions. If

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[5] **Response to Comments, Appendix B, "Reasonable Potential Determination," June 14, 1999.**

IDEQ does not re-certify the mixing fraction of 0.5[6], the reasonable potential will be re-evaluated based on the mixing fraction that is certified or based on the meeting criteria end-of-pipe, if no mixing fraction is certified.

Flow Conditions (Q_u, Q_e)

The flows used to evaluate reasonable potential for copper and lead based on data collected during 2000 - 2001 are the same flows used in developing the current permit:

- C   The 1 day, 10 year low flow (1Q10) is used for the protection of aquatic life from acute effects. It represents the lowest daily flow that is expected to occur once in 10 years.
- C   The 7 day, 10 year low flow (7Q10) is used for the protection of aquatic life from chronic effects. It the lowest 7 day average flow expected to occur once in 10 years.

TABLE 2	FLOWS USED IN RP EVALUATION	
Season	**1Q10, cfs**	**7Q10,cfs**
April 1 - September 30	109	170
October 1 - March 31	86	95
Effluent Design Flow	**15 MGD**	**23.2 cfs**

Maximum Projected Effluent Concentration, (C_e)

When determining the projected receiving water concentration, EPA's *Technical Support Document for Water Quality-based Toxics Controls* (TSD, 1991) recommends using the maximum projected effluent concentration. To determine the maximum projected effluent concentration (C_e) EPA has developed a statistical approach to better characterize the effects of effluent variability. The approach combines knowledge of effluent variability as estimated by a coefficient of variation (CV) with the uncertainty due to a limited number of data to project an estimated maximum concentration for the effluent. After the CV for each parameter has been calculated, the CV is paired with the reasonable potential multiplier (RPM) found in Table 3-1 of EPA's TSD to derive the maximum projected effluent concentration (C_e).

For this permit, the maximum projected concentration (C_e) for the effluent is equal to the 95th percentile observed concentration value (or the highest observed value if the 95th percentile cannot be calculated) of the data set multiplied by the RPM. Table 3 summarizes the CVs, reasonable potential multipliers, 95th percentile effluent concentration and maximum projected concentration (C_e) used to re-evaluate reasonable potential for copper and lead for proposed

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[6]   **IDEQ certified an MF of 0.5 for the current permit.**

modification. The proposed requirements are based on a data set collected between 2000 and 2001 using updated collection and analytical techniques. As a result, the maximum projected effluent concentrations for copper and lead and the CVs are less than those used in developing the current permit.

TABLE 3	Reasonable Potential Inputs for Proposed Permit Modification			
		April - Sept	Oct - March	Basis for Input
Mixing Fraction (MF)	Copper	0.5		**Previous State certification**
	Lead	0.5		
Translator	Copper	0.794		**EPA calculations using new data submitted by City**
	Lead	0.855		
Background Conc. 95th %-ile, (C_u)	Copper, ug/L (dissolved)	0^1	2.1^2	**Data collected by City upstream of Outfall 001**
	Lead, ug/L (dissolved)	0^3	0.3^4	
Effluent, 95th %-ile	Copper, ug/L (Total Recoverable)	10.76	13.71	**Data collected from Outfall 001 from 2000-2001**
	Lead, ug/L (Total Recoverable)	1.4375	1.55	
CV	Copper	0.29	0.31	**EPA calculations**
	Lead	0.45	0.39	
Reasonable Potential Multiplier (RPM)	Copper	1.58^5	1.58^6	**Table 3-1, TSD**
	Lead	2.03^7	1.86^8	
Maximum Projected Concentration, (C_e)	Copper = RPM X Trans X Eff 95th-ile	13.5	17.2	
	Lead = RPM X Trans X Eff 95th-ile	2.50	2.46	
Reasonable Potential Projected?	Copper	No	No	
	Lead	No	No	

[1]	Number of summer upstream samples:	15	[2]	Number of winter upstream samples:	11
[3]	Number of summer upstream samples:	15	[4]	Number of winter upstream samples:	14
[5]	Number of summer effluent samples:	17	[6]	Number of winter effluent samples:	20
[7]	Number of summer effluent samples:	17	[8]	Number of winter effluent samples:	20

Dissolved vs Total Metals (Translators)

When determining the reasonable potential of these parameters to violate water quality standards the projected receiving water concentration is compared to the criteria. The aquatic life criteria for copper and lead are expressed as dissolved. The maximum projected receiving water concentration, based on the effluent concentration, is expressed as total recoverable.

The dissolved form is the concentration of the metal that will pass through a 0.45 micron membrane filter assembly. The total form is the concentration of metal in an unfiltered sample. In order to compare the projected receiving water concentration, which is expressed as total, to a dissolved criterion a "translator" is used to translate the total recoverable effluent concentration to a dissolved concentration. In this case, the City collected new data since 2000 to be used in developing updated site-specific translators for copper and lead. The data comprised 20-40 samples each of effluent and receiving water samples. Using this data, EPA calculated new translators using EPA translator guidance.[7] Table 3 above lists the translators used for copper and lead.

Upstream (Background) Concentration (C_u)

The background concentrations used for the proposed permit modification are less than those used in developing the current permit. The differences are attributable to the new data collected. The previous data collected included samples that were collected using "near-clean" techniques, as well as clean techniques. As a result, background concentration in some cases significantly decreased.

Reasonable Potential Calculations

An example calculation, for copper, during April 1 - September 30 is included here.

1. Copper

    (a) Determine if there is a reasonable potential for the acute aquatic life criterion to be violated:

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[7]   *The Metals Translator: Guidance for Calculating a Total Recoverable Permit Limit from a Dissolved Criterion*, **EPA 823-B-96-007, June 1996.**

The upstream flow used to make the determination is the 1Q10 (109 cfs). Assume the State will allow a 0.50 mixing fraction. The upstream concentration (as dissolved) is 0.0：g/L. In order to compare the effluent value to the criterion, which is expressed as dissolved, the site specific translator for copper must be used. The maximum projected effluent concentration, Ce, must be converted to dissolved:

C_e(diss) = C_e(TR) X translator X RPM[8] = 10.76 X 0.794 X 1.58 = 13.5：g/L

$$C_d = \frac{(C_e \text{ X } Q_e) + (C_u \text{ X } (Q_u \text{ X MF}))}{Q_e + (Q_u \text{ X MF})}$$

$$= \frac{(23.2 \text{ X } 13.5) + (0.0 \text{ X } (109 \text{ X } .50))}{23.2 + (109 \text{ X } 0.50)} = 4.03 : \text{g/L}$$

Since 4.03：g/L is less than the acute aquatic life criterion (20.7：g/L), there is no reasonable potential for the effluent to cause an exceedance of the water quality standard and an effluent limit is not required.

(b)   Determine if there is a reasonable potential for the chronic aquatic life criterion to be violated:

The upstream flow used to make the determination is the 7Q10 (170 cfs). Assume the State will allow a 0.50 mixing fraction. The upstream concentration 0.0：g/L.

$$C_d = \frac{(C_e \text{ X } Q_e) + (C_u \text{ X } (Q_u \text{ X MF}))}{Q_e + (Q_u \text{ X MF})}$$

$$= \frac{(23.2 \text{ X } 13.5) + (0 \text{ X } (170 \text{ X } .50))}{23.2 + (170 \text{ X } 0.50)} = 2.89 : \text{g/L}$$

Since 2.89：g/L is less than the chronic aquatic life criterion (13.1：g/L), there is no reasonable potential for the effluent to cause an exceedance of the water quality criterion and an effluent limit is not required. The draft permit proposes to delete the effluent limits for copper.

2.   Lead **[October 1 - March 31]**

(a)   Determine if there is a reasonable potential for the acute aquatic life criterion to be violated:

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[8]   **"RPM" = reasonable potential multiplier**

The upstream flow used to make the determination is the 1Q10 (86 cfs). Assume the State will allow a 0.50 mixing fraction. The upstream concentration (as dissolved) is 0.3 ：g/L. In order to compare the effluent value to the criterion, which is expressed as dissolved, the site specific translator for lead must be used. The maximum projected effluent concentration, Ce, must be converted to dissolved:

C_e(diss) = C_e(TR) X translator X RPM = 1.55 X 0.855 X 1.86 = 2.46 ：g/L

$$C_d = \frac{(C_e \ X \ Q_e) + (C_u \ X \ (Q_u \ X \ MF))}{Q_e + (Q_u \ X \ MF)}$$

$$= \frac{(23.2 \ X \ 2.46) + (0.3 \ X \ (86 \ X \ .50))}{23.2 + (86 \ X \ 0.50)} = 1.06 ：g/L$$

Since 1.06 ：g/L is less than the acute aquatic life criterion (62 ：g/L), there is no reasonable potential for the effluent to cause an exceedance of the water quality standard and an effluent limit is not required.

(b)   Determine if there is a reasonable potential for the chronic aquatic life criterion to be violated:

The upstream flow used to make the determination is the 7Q10 (95 cfs). Assume the State will allow a 0.50 mixing fraction. The upstream concentration 0.3 ：g/L.

$$C_d = \frac{(C_e \ X \ Q_e) + (C_u \ X \ (Q_u \ X \ MF))}{Q_e + (Q_u \ X \ MF)}$$

$$= \frac{(23.2 \ X \ 2.46) + (0.3 \ X \ (95 \ X \ .50))}{23.2 + (95 \ X \ 0.50)} = 1.01 ：g/L$$

Since 1.01 ：g/L is less than the chronic aquatic life criterion (2.4 ：g/L), there is no reasonable potential for the effluent to cause an exceedance of the water quality standard and an effluent limit is not required. The draft permit proposes to delete the effluent limits for lead.

Refer to Table 3 above for the results of the reasonable potential evaluations for the other seasons.